Kitaev Spin Liquids

Context

Theory

Several examples where QSLs (quantum spin liquids) are rigorously known to be the ground states

Lack of suitable theoretical methods

- Analytic large $S$, large $N$ calculations "biased"
  - misses out on crucial aspect: entanglement
- Computational methods $\Rightarrow$ need very high precision $\Rightarrow$ ground-state nature
Kitaev Spin Liquid

Exactly Soluble \( \longrightarrow \) (decomposition of Majorana fermions)

\[ \uparrow \]

we will discuss them shortly

Fractionalization of spin can be "traced"

\[ \downarrow \]

(Majorana) fermion degree of freedom

static \( Z_2 \)
gauge field with a \( \Delta \)

KSL in ground state flux sector

Transitions out of ASL

\[ \uparrow \]

"confinement" of Majorana fermions
- Experimental Realizations
  Crucial Aspects
  - Large Spin-Orbit Coupling
  - Bonding Geometry
- Link to Toric Code (periodic boundary conditions)
  - Topological Order
  - Simple Topological Quantum Error Correcting Code
- Local errors, thermal noise and decoherence are the main obstacles in the realization of a quantum computer
- Topological properties (nonlocal) may be a way to address this
in physical systems

- Qubits encoded in topological states may be robust to local perturbations

- Quantum Computing

- Quantum Magnetism

- Kitaev Spin Liquid

- Strongly Correlated Electrons

- Solid State Chemistry

Quite impressive for a "toy model"!